

What is claimed is:

1 1. A method for controlling focus parameters of an exposure tool in a
2 lithographic process for patterning a substrate of a semiconductor wafer, comprising:
3 providing a bare semiconductor wafer substrate or a substrate formed by
4 depositing a film onto the surface of a semiconductor wafer;
5 providing a pattern having a first edge and a second edge, the first edge and the
6 second edge being substantially parallel and limiting the pattern, the pattern including a
7 plurality of structural elements, each of the structural elements having a characteristic
8 feature size;
9 selecting a first structural element and a second structural element, the first
10 structural element having a first distance to the first edge and the second structural
11 element having a second distance to the first edge;
12 selecting the characteristic feature size of the first structural element larger than
13 the characteristic feature size of the second structural elements when the first distance is
14 larger than the second distance;
15 selecting the characteristic feature size of the first structural element substantially
16 equal to the characteristic feature size of the second structural elements when the first
17 distance is substantially equal to the second distance;
18 disposing the pattern on a photo mask;
19 depositing a photoresist film layer on a surface of the substrate;
20 projecting the pattern onto the photoresist film layer using the photo mask in the
21 exposure tool having a characteristic focus parameter;

22 developing the photoresist film layer to form a three-dimensional resist pattern on
23 the surface of the substrate by removing a first part of the photoresist film layer being
24 exposed with a first exposure dose, the resist pattern corresponding to the pattern and
25 having a corresponding first edge and a corresponding second edge;
26 determining a first dimension of the resist pattern between the corresponding first
27 edge and the corresponding second edge; and
28 determining the characteristic focus parameter of the exposure tool as a function
29 of the first dimension of the resist structure.

1 2. The method according to claim 1, wherein the structural elements are
2 square shaped and wherein the characteristic dimension is the area of each the square
3 shaped element.

1 3. The method according to claim 1, wherein the structural elements are
2 circular shaped and wherein the characteristic dimensions is the area of each the circular
3 shaped element.

1 4. The method according to claim 1, wherein the step of providing a pattern
2 includes disposing a reference pattern on the photo mask in proximity of the pattern, the
3 reference pattern having a width which is substantially equal to the distance between the
4 first edge and the second edge.

1 5. The method according to claim 4, wherein the step of determining the
2 focus of the exposure tool as a function of the first dimension is performed by comparing
3 the first dimension of the resist pattern to the width of the reference pattern.

1 6. The method according to claim 1, wherein the first edge and the second
2 edge limiting the pattern in a range from 0.5 to 4.0 μm .

1 7. The method according to claim 1, wherein the characteristic feature sizes
2 of the elements are selected in a range from 45 to 250 nm.

1 8. The method according to claim 1, wherein the resist film layer has an
2 exposure dose threshold, choosing the first exposure dose threshold and the first exposure
3 dose such that the resist pattern forms pillars on the substrate of the semiconductor wafer.

1 9. The method according to claim 1, wherein the resist film layer has an
2 exposure dose threshold, choosing the first exposure dose threshold and the first exposure
3 dose such that the resist pattern forms holes in the resist film layer on the substrate of the
4 semiconductor wafer.

1 10. The method according to claim 1, wherein the step of determining the first
2 dimension of the resist pattern includes recording an image in a measurement region, the
3 measurement region including the corresponding first edge and the corresponding second
4 edge.

1 11. The method according to claim 10, wherein the step of recording the image
2 includes determining an intensity distribution of the image.

1 12. The method according to claim 11, wherein the step of determining the
2 first dimension of the resist pattern includes calculating the center of gravity value of the
3 image distribution.

1 13. The method according to claim 10, wherein the step of recording an image
2 is performed during optical inspection, overlay metrology, scatterometry or critical
3 dimension scanning electron microscopy.

1 14. The method according to claim 13, further comprising:
2 providing a measurement pattern, the measurement pattern being usable as an
3 overlay target, an alignment mark, a scatterometry mark or a critical dimension
4 measurement bar; and
5 disposing the measurement pattern on the photo mask, wherein the pattern
6 forming a sub portion of the measurement pattern.

1 15. An arrangement for controlling focus parameters of an exposure tool
2 during lithographic exposure, comprising:
3 a semiconductor wafer with a substrate having a photoresist film layer on a
4 surface of the substrate;

5 a pattern on a photo mask, the pattern having a first edge and a second edge, the
6 first edge and the second edge being substantially parallel and limiting the pattern, the
7 pattern including a plurality of structural elements, each of the structural elements having
8 a characteristic feature size;

9 means for selecting a first structural element and a second structural element, the
10 first structural element having a first distance to the first edge and the second structural
11 element having a second distance to the first edge;

12 means for selecting the characteristic feature size of the first structural element
13 larger than the characteristic feature size of the second structural elements when the first
14 distance is larger than the second distance;

15 means for selecting the characteristic feature size of the first structural element
16 substantially equal to the characteristic feature size of the second structural elements
17 when the first distance is substantially equal to the second distance;

18 means for projecting the pattern onto the photoresist film layer using the photo
19 mask in an exposure tool having a characteristic focus parameter;

20 means for developing the photoresist film layer to form a three-dimensional resist
21 pattern on the surface of the substrate by removing a first part of the photoresist film layer
22 being exposed with a first exposure dose, the resist pattern corresponding to the pattern
23 and having a corresponding first edge and a corresponding second edge;

24 means for determining a first dimension of the resist pattern between the
25 corresponding first edge and the corresponding second edge; and

26 means for determining the characteristic focus parameter of the exposure tool as a
27 function of the first dimension of the resist structure.

1 16. The arrangement according to claim 15, wherein the structural elements
2 are square shaped and wherein the characteristic dimension is the area of each the square
3 shaped element.

1 17. The arrangement according to claim 15, wherein the structural elements
2 are circular shaped and wherein the characteristic dimensions is the area of each the
3 circular shaped element.

1 18. The arrangement according to claim 15, further comprising:
2 a reference pattern on the photo mask in proximity of the pattern, the reference
3 pattern having a width which is substantially equal to the distance between the first edge
4 and the second edge.

1 19. The arrangement according to claim 18, wherein the means for
2 determining the focus of the exposure tool as a function of the first dimension being able
3 to compare the first dimension of the resist pattern to the width of the reference pattern.

1 20. The method for controlling focus parameters of an exposure tool,
2 comprising:
3 providing an exposure tool having a characteristic minimal resolution, the minimal
4 resolution depending on a focus parameter of the exposure tool;

5 providing a line shaped pattern having a width, the line shaped pattern including a
6 plurality of individually sized textures and having a first edge and a second edge, the first
7 edge and the second edge limiting the width of the line shaped pattern;

8 selecting the feature sizes as a function of the distance of the features to the first
9 edge, the feature sizes decreasing monotonically from a maximum value close to the first
10 edge to a minimum value close to the second edge;

11 exposing an image of the line shaped pattern onto a resist film layer on a substrate
12 to create a latent image of the line shaped pattern, the latent image having a further width,
13 the further width being less or equal to the width as a function of the minimal resolution;

14 determining the minimal resolution by comparing the further width of the latent
15 image and the width of the line shaped pattern; and

16 determining the focus parameter as a function of the minimal resolution.

1 21. An arrangement for controlling focus parameters of an exposure tool
2 during lithographic exposure, comprising:

3 a semiconductor wafer with a substrate having a photoresist film layer on a
4 surface of the substrate;

5 a pattern on a photo mask, the pattern having a first edge and a second edge, the
6 first edge and the second edge being substantially parallel and limiting the pattern, the
7 pattern including a plurality of structural elements, each of the structural elements having
8 a characteristic feature size;

9 a first selector for selecting a first structural element and a second structural
10 element, the first structural element having a first distance to the first edge and the second
11 structural element having a second distance to the first edge;
12 a second selector for selecting the characteristic feature size of the first structural
13 element larger than the characteristic feature size of the second structural elements when
14 the first distance is larger than the second distance;
15 a third selector for selecting the characteristic feature size of the first structural
16 element substantially equal to the characteristic feature size of the second structural
17 elements when the first distance is substantially equal to the second distance;
18 a projector for projecting the pattern onto the photoresist film layer using the
19 photo mask in an exposure tool having a characteristic focus parameter;
20 a developer for developing the photoresist film layer to form a three-dimensional
21 resist pattern on the surface of the substrate by removing a first part of the photoresist
22 film layer being exposed with a first exposure dose, the resist pattern corresponding to the
23 pattern and having a corresponding first edge and a corresponding second edge;
24 a first calculator for determining a first dimension of the resist pattern between the
25 corresponding first edge and the corresponding second edge; and
26 a second calculator for determining the characteristic focus parameter of the
27 exposure tool as a function of the first dimension of the resist structure.

1 22. The arrangement according to claim 21, wherein the structural elements
2 are square shaped and wherein the characteristic dimension is the area of each the square
3 shaped element.

1 23. The arrangement according to claim 21, wherein the structural elements
2 are circular shaped and wherein the characteristic dimensions is the area of each the
3 circular shaped element.

1 24. The arrangement according to claim 21, further comprising:
2 a reference pattern on the photo mask in proximity of the pattern, the reference
3 pattern having a width which is substantially equal to the distance between the first edge
4 and the second edge.

1 25. The arrangement according to claim 24, wherein the second calculator
2 adapted to compare the first dimension of the resist pattern to the width of the reference
3 pattern.